

Claims

- [c1] 1. A method for operating a vehicle to reduce exhaust emissions, the vehicle including an engine, an electric machine, an energy storage device capable of providing energy to operate the electric machine, and a catalyst for facilitating a reaction in exhaust gas from the engine, the method comprising:
- setting at least one engine parameter to effect an increase in a rate of temperature increase of the catalyst when the engine is operating, thereby decreasing the time required for the catalyst to reach a temperature whereat emissions are reduced;
- operating the engine such that engine output power is generally constant when an output power of the energy storage device is within a first predetermined range; and
- adjusting the at least one engine parameter, thereby changing the engine output power, when the output power of the energy storage device is outside the first predetermined range, the at least one engine parameter being adjusted to facilitate a change in the output power of the energy storage device from outside the first predetermined range into the first predetermined range.

- [c2] 2. The method of claim 1, wherein the at least one engine parameter includes at least one of an amount of air provided to the engine, an amount of fuel provided to the engine, and an engine spark timing.
- [c3] 3. The method of claim 1, further comprising using a first filter to slow the change of the engine output power when the output power of the energy storage device is within a second predetermined range.
- [c4] 4. The method of claim 3, further comprising using a second filter to slow the change of the engine output power when the output power of the energy storage device is within a third predetermined range, the second filter facilitating a faster change of the engine output power than the first filter.
- [c5] 5. The method of claim 4, wherein the third predetermined range is defined by an output power limit of the energy storage device and a first predetermined power value, the first predetermined power value being at least partly based on a response time of the engine to changes to the at least one engine parameter.
- [c6] 6. The method of claim 5, wherein the first predetermined range is at least partly defined by at least one set point power level of the energy storage device.

- [c7] 7. The method of claim 1, further comprising adjusting the at least one engine parameter to effect a reduction in the rate of temperature increase of the catalyst when the engine is operating when the catalyst temperature is at least a predetermined temperature or the engine has been operating for a predetermined amount of time.
- [c8] 8. The method of claim 7, wherein adjusting the at least one engine parameter to effect a reduction in the rate of temperature increase of the catalyst when the engine is operating includes using a third filter to slow the change of the engine output power.
- [c9] 9. The method of claim 8, wherein the third filter is removed when an operator of the vehicle demands an increase in vehicle power greater than a predetermined power increase.
- [c10] 10. The method of claim 1, further comprising:
operating the electric machine to provide power to propel the vehicle, thereby augmenting the engine output power, when the at least one engine parameter is set to effect an increase in the rate of temperature increase of the catalyst.
- [c11] 11. A method for operating a vehicle to reduce exhaust emissions, the vehicle including an engine, an electric

machine, an energy storage device capable of providing energy to operate the electric machine, and a catalyst for facilitating a reaction in exhaust gas from the engine, the method comprising:

determining a desired output power for the vehicle;
operating the vehicle in a first mode when at least one predetermined condition is met, the first mode including providing at least some of the desired vehicle output power with the electric machine when the desired vehicle output power is non-zero, setting at least one engine parameter to effect an increase in a rate of temperature increase of the catalyst when the engine is operating, operating the engine such that engine output power is generally constant when an output power of the energy storage device is within a first predetermined range, and adjusting the at least one engine parameter, thereby changing the engine output power, when the output power of the energy storage device is outside the first predetermined range, the at least one engine parameter being adjusted to facilitate a change in the output power of the energy storage device from outside the first predetermined range into the first predetermined range;
and

operating the vehicle in a second mode when the at least one predetermined condition is not met, the second mode including operating the engine based on the de-

sired vehicle output power and a state of the energy storage device.

- [c12] 12. The method of claim 11, wherein the at least one predetermined condition includes at least one of the catalyst temperature being at least a predetermined temperature and the engine operating for a predetermined time.
- [c13] 13. The method of claim 11, wherein setting at least one engine parameter includes retarding a spark timing of the engine.
- [c14] 14. The method of claim 11, further comprising operating the vehicle in a transition mode between the first mode and the second mode, the transition mode including changing the engine output power from a first level to a second level and filtering the change in engine output power during at least a portion of the change from the first level to the second level, thereby slowing the change in engine output power from the first level to the second level.
- [c15] 15. The method of claim 14, further comprising exiting the transition mode when at least one exit condition is met, the at least one exit condition including at least one of the engine power being less than a predetermined

amount from the second level and a driver power demand being greater than a predetermined power demand.

[c16] 16. The method of claim 11, wherein the first mode further includes using a first filter to slow the change of the engine output power when the output power of the energy storage device is within a second predetermined range.

[c17] 17. The method of claim 11, wherein the first mode further includes using a second filter to slow the change of the engine output power when the output power of the energy storage device is within a third predetermined range, the second filter facilitating a faster change of the engine output power than the first filter.

[c18] 18. The method of claim 17, wherein the third predetermined range is defined by an output power limit of the energy storage device and a first predetermined value.

[c19] 19. A vehicle, comprising:
an engine;
an electric machine operable to drive the vehicle;
an energy storage device capable of providing energy to operate the electric machine;
a catalyst capable of facilitating a reaction in exhaust gas

from the engine; and
at least one controller configured to set at least one engine parameter to effect an increase in a rate of temperature increase of the catalyst when the engine is operating, thereby decreasing the time required for the catalyst to reach a temperature whereat emissions are reduced, the at least one controller being further configured to control the engine to provide a generally constant output power when an output power of the energy storage device is within a first predetermined range, and to adjust the at least one engine parameter, thereby changing the engine output power, when the output power of the energy storage device is outside the first predetermined range, the at least one engine parameter being adjusted to facilitate a change in the output power of the energy storage device from outside the first predetermined range into the first predetermined range.

[c20] 20. The vehicle of claim 19, wherein the at least one engine parameter includes at least one of an amount of air provided to the engine, an amount of fuel provided to the engine, and an engine spark timing.

[c21] 21. The vehicle of claim 19, wherein the at least one controller is further configured to adjust the at least one engine parameter to effect a reduction in the rate of temperature increase of the catalyst when the engine is

operating when the catalyst temperature is at least a predetermined temperature or the engine has been operating for a predetermined amount of time.